

# Clinical, Scholarly & Campus Information Hypertext Tools At Columbia-Presbyterian Medical Center

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## ABSTRACT

*In conjunction with other researchers at Columbia-Presbyterian Medical Center (CPMC) we have developed a number of hypertext and free text retrieval computer applications aimed at an extremely diverse audience which includes students and faculty in a university setting as well as health care providers and patients in hospital and clinic settings. Hypertext and free text systems offer features which make them ideal for presenting information in a wide variety of contexts; however, they also have several major weaknesses which must be addressed before these applications can be useful tools. We have learned to maximize the strengths and minimize the weaknesses to present material in a manner that is individualized to the needs of each user from the research scientist in the lab to the patient at the bedside.*

## INTRODUCTION

At the Columbia-Presbyterian Medical Center we have developed a variety of computer applications which use hypertext and free text retrieval techniques to present clinical, scholarly and campus news information relevant to health care professionals. Prototypes of three such applications developed using Folio Views (tm) software were presented by A. Clarke and S. Shea at SCAMC '91 [1]. Since that time, we have greatly expanded several of the initial applications and have added seven other applications using Folio Views. Our experience with these applications has refined our perceptions of both the strengths and the weaknesses of hypertext as a learning tool, and specifically as a tool for presenting health care information.

The formation of an Integrated Academic Information Management System (IAIMS) at CPMC has meant that the applications we develop

can be used in a variety of environments on over 1,000 computer terminals [2]. The applications are in use in a variety of contexts at the Medical Center. Some are used by students and researchers at the Health Sciences Library, others are used by faculty at the College of Physicians and Surgeons and the Schools of Nursing and Public Health, others are in use at the 85 patient care units at the five hospitals and outlying clinics that are part of the Presbyterian Hospital, and some of the applications are in use in all of these settings.

The diversity of users at CPMC presented us with some unique challenges in developing computer tools which are capable of meeting the needs of a varied audience. Hypertext and free text retrieval systems offer several features useful in this development effort -- the multilinearity and interconnectivity of hypertext and the flexibility of free text retrieval are all features which allow software to be individualized for a wide variety of learning needs. On the other hand, features such as the navigational disorientation and 'cognitive overhead' [3] of hypertext, and the unstructured nature of free text retrieval, make it possible for new users to become "lost" in the information. We believe we have come up with a number of workable solutions to these problems including strengthening user help systems, providing extra navigational tools, providing a standard interface for all systems, providing interfaces that are similar to printed sources, and providing highly structured indexes and pre-coded links in addition to the free text capabilities of the applications.

## DIVERSE TOOLS IN A MULTI-CONTEXT LEARNING ENVIRONMENT

The hypertext applications at CPMC can be divided into three major areas -- scholarly, clinical, and campus information.

Clinical and scholarly resources include Grants and Contracts Announcements, Guide to Clinical and Preventive Services [4], Clinical Trial Alerts, Medical Logic Modules Library, Physician's Desk Reference (tm) (PDR) and the Presbyterian Hospital Nursing Standards and Patient Education System. The Grants and Contracts database assists researchers in finding out what's available and what's being done in current research grants. Clinical Trial Alerts are provided by the National Library of Medicine. The Medical Logic Modules Library provides a sample set of the Arden Syntax project of the Medical Informatics Department [5]. The Physician's Desk Reference includes a fully indexed and searchable version of the full text of the PDR, the PDR for Nonprescription Drugs and the PDR for Ophthalmology. The Nursing Standards and Patient Education System includes care plans, protocols and procedures as well as patient education fact sheets, teaching protocols, and lists of patient and family support group resources, all developed by the Nursing Division of Presbyterian Hospital.

Campus information applications include an Electronic Tour of the Library, a Guide to the CPMC Network, the Information News Newsletter and the CPMC Telephone Directory. The Guide to the Network provides a road map of the various applications available on the IAIMS network including access instructions, and contacts for obtaining ID's for restricted applications, such as patient records. The Electronic Tour of the Health Sciences Library presents an overview of library resources including course reserve procedures, a description of holdings, computer classes and Medline training sessions. The Information News Newsletter is an online duplicate of the IAIMS newsletter that presents updates on research topics and scheduling information for medical informatics events. The Telephone Directory gives phone numbers and email addresses of all campus personnel.

## MULTILINEARITY

The wide range of information and the diversity of learning contexts that are covered in these applications calls for robust computer tools which can meet the needs of many different learners at many stages of learning. The advanced learners will be bored or slowed down by information appropriate for beginners. And the beginners will be lost or intimidated by information aimed at

advanced learners. Hypertext is multilinear -- it offers a variety of pathways through information and thus overcomes this difficulty by allowing users to choose the informational pathways appropriate to their own needs. [6]

For example, in our hypertext version of the PDR we originally presented only two access paths -- a search by trade name and a full text search. Now, taking fuller advantage of hypertext's multilinearity, we offer searches by generic name and therapeutic class in addition to the trade name and full text searches (see Figure 1). An experienced user of the PDR can go directly to the product they are interested in while a person less sure of the information they need can search through the appropriate index.

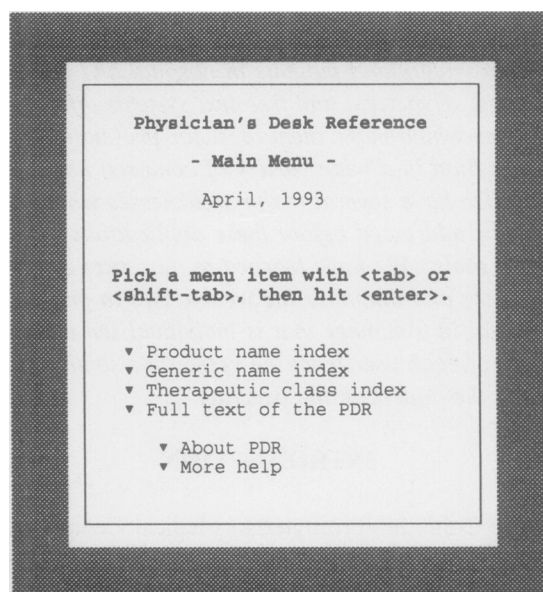


Figure 1. Main Menu for PDR

Our hypertext version of the Information News Newsletter also takes advantage of hypertext's multilinearity. Users have a variety of pathways to the information they seek -- they can read the current or past issues, search the full text or search a cumulative index of article titles.

The Nursing Standards & Patient Education System makes use of multilinearity in several ways. Experienced users of the system can directly retrieve documents by title or document ID number. Those who are less familiar with the contents or with what document is called for in a

particular clinical situation have other pathways to the same information (see Figure 2). For example, if a nurse is looking for documents to assist a patient with asthma, the Body Systems Index presents a simple decision tree. The nurse

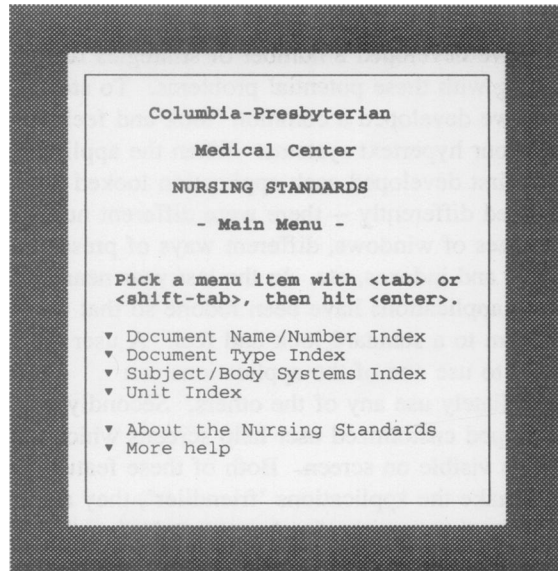


Figure 2. Main Menu of Nursing Standards

first decides which body system is involved -- 'respiratory'. The nurse then decides which subsystem is involved -- 'lower respiratory'. The next decision is which document is appropriate in the current situation -- the 'adult asthma care plan', the patient education fact sheet 'Living a Full Life with Asthma', or one of the protocols or procedures associated with the patient's condition. Once the document has been selected it is then a matter of choosing which portions of it are relevant, for example, within the adult asthma care plan the nurse might read the section on the nursing diagnosis 'ineffective airway clearance'. In this case the nurse has traversed a simple decision tree - - 'respiratory', 'lower respiratory', 'adult asthma care plan', 'ineffective airway clearance'. In another situation the same decision tree might be traveled in reverse -- by initiating a full text search for 'ineffective airway clearance' the nurse would come up with a list of 'pertussis', 'pneumonia', 'asthma', etc. and could then proceed to the individual documents needed. This type of decision tree is both an assistance to finding the information and a way of teaching or reinforcing knowledge about how the information is structured.

## INTERCONNECTIVITY

A second feature of hypertext which makes it well suited to applications in a multi-context environment is its ability to interconnect information between sources regardless of the physical location of the sources in the text.

This interconnectivity can occur both within applications and between applications. For example, if a user searches the list of articles in the Information News Newsletter application for the word 'Medline', articles about Medline will be displayed together regardless if they are in the current issue or an issue from two years ago. If a user searches the PDR for 'ibuprofen' the articles on Motrin (tm), Nuprin (tm) and Advil (tm) will be displayed together regardless of the fact that they occur in different locations within the text.

The Electronic Tour of the Health Sciences Library presents an example of interconnections between applications. The tour mentions, in a general way, a variety of computer and medical informatics seminars offered at CPMC; a hypertext link allows users to jump from the Library Tour to the current edition of the online Information News Newsletter which has the latest schedule for these events. The Library Tour also mentions a variety of computer databases and hypertext systems that are provided in the Library's Microcomputer and Media Center; a hypertext link connects the user with the online Guide to the CPMC Network which provides descriptions of these resources. Such connections between applications assist the user in moving smoothly between information sources, and they also make the programmer's task much easier -- the information is stored in only one application although it can be accessed from other applications.

The Nursing Standards and Patient Education System illustrates a further extension of interconnectivity. When a user searches for a disease condition such as asthma or AIDS, the application connects together documents of very different sorts intended for completely different audiences. Such a search would produce care plans and procedures with detailed technical information aimed at the health care providers as well as patient education fact sheets which are aimed at the patient and the patient's family and significant others. The patient education materials are specifically targeted for nontechnical readers. They are written at a sixth grade reading level and assume no prior

knowledge of health information. Additionally, the hospital is currently adding Spanish language versions of these materials to the application. This will allow even greater targeting of the information to the intended audience. Along with the patient fact sheets and the care plans, two additional kinds of documents are interconnected by the application. A teaching protocol gives the nurse detailed information on what to teach the patient and family during the hospital stay and on discharge. And a list of support groups gives phone numbers and addresses of outside agencies that can support the patient and family after they leave the hospital. Rather than placing the teaching protocols, patient handouts and support groups lists in a separate application, hypertext allows these materials to be fully integrated with the technical documents, thus ensuring that patient education will be an integral part of the hospital's care giving.

One final example of hypertext's interconnectivity is a feature we call 'the electronic suggestion box'. The Library Tour has a hypertext link which allows users to submit general suggestions directly to the Library's electronic-mail (email) box. A second link allows users to fill out a form with specific suggestions for additions to the Library's collection which is also emailed to the Library. In both cases the user is completely insulated from the email process -- they can make an email connection with the library without knowing anything about email. There are similar suggestion buttons in the Nursing Standards and Patient Education System -- both a general suggestion link and one which allows each nursing unit to assist in the customization of the application. The nursing unit link encourages nurses to submit lists of documents that are used in their own patient care area. These lists will be fed back into the next revision of the application. The application thus becomes a living dynamic system that encourages nurses to note ways of improving patient care and patient education and to have their perceptions alter future versions of the application.

#### **ADDRESSING WEAKNESSES OF HYPERTEXT**

There are two major problems which are endemic to hypertext systems: (i) navigational disorientation and (ii) what E. J. Conklin has called 'cognitive overhead'. Cognitive overhead refers to the fact that developing a picture of hypertext structure is a mental burden over and above the burden of finding the specific information. The very features which

are hypertext's strengths can also be its downfall -- flexibility can encourage lack of structure, multilinearity can encourage overloading the user with choices, interconnectivity can make the user lose any sense of 'where they are' and 'how they got there'. [3]

We have developed a number of strategies for dealing with these potential problems. To start with, we developed a common 'look and feel' for all of our hypertext systems. When the applications were first developed each application looked and operated differently -- there were different numbers and sizes of windows, different ways of presenting menus and indexes, etc. In the last year nearly all of the applications have been redone so that they conform to a standard look and feel. A user who learns to use one of the applications can immediately use any of the others. Secondly, we developed customized user help screens which are always visible on screen. Both of these features not only make the applications 'friendlier', they also decrease the cognitive load -- remembering the exact keys to press or remembering where to look on the screen are no longer a problem.

To decrease navigational disorientation, we instituted a universal 'home base' key in all the applications. However many levels the user has traveled or however many paths they have taken, a single key will return them to a main menu screen from which they may start a fresh search.

Although all of the applications allow users to create ad-hoc links with free text searching, we recognized that this may be beyond the capabilities of some users. We therefore provide additional highly structured paths to all information. Each of the applications has at least one index. The PDR has three indexes and the Nursing Standards has five. These indexes mean that users can find any item of information through pre-coded links and do not need to do free text searching unless they want to do so.

In several of the applications we have provided additional structure by making the electronic version replicate as closely as possible print versions of the information. Most health care professionals, for example, are well acquainted with the print version of the PDR. Our electronic version has many added search capabilities, however, the first time user or computer novice can ignore these capabilities and stick with 'what is familiar to them.

The indexes are simple alphabetic lists just like the printed version. The full text is available for browsing page by page just like the printed version. Similarly, the electronic Nursing Standards replicate exactly the printed manuals found at every nursing station.

### **DIRECTIONS FOR THE FUTURE**

The techniques we have used to make hypertext applications accessible appear to be working quite well. The revised version of the Nursing Standards had over 1,700 logins in its first month of use and was being used by many computer novices who are able to access the system successfully with a minimum of training.

We plan to develop new applications and expand the existing applications into new areas. We are developing a Gopher/World Wide Web/WAIS server and intend to link from our existing hypertext systems directly into the worldwide network of information sources. We are investigating switching computer platforms from the current DOS/Novell environment to a distributed platform which would allow further kinds of interconnectivity. Such a switch in platforms would also facilitate linking between these hypertext applications and other computer applications at CPMC. In order to facilitate such extensions, we designed the text processing utilities which create the Folio Views applications in a manner that allows easy conversion to standardized text processing formats such as the Standardized General Markup Language (SGML). Another exciting dimension is the development of groupware editing features. These features allow multiple authors to share ideas within a hypertext system and also allow users to customize hypertexts to more specifically meet their own needs.

In summary, we have found hypertext to be a useful tool in CPMC's multi-context learning environment. It is a tool that is capable of serving the needs of both novice and experienced computer users and which is able to present information useful to persons with widely divergent knowledge levels encompassing both health care professionals and the patients that they serve.

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